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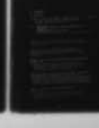
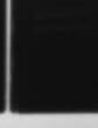
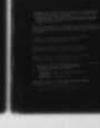
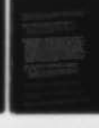
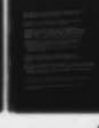
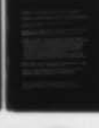
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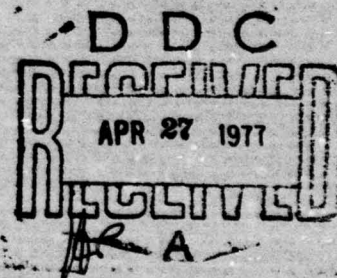
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by

B. Einarsson



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Abstract:

This bibliography has been written at the request of the IFIP Working Group on Numerical Software (IFIP WG 2.5), and is intended to serve both members of the working group and others intent on improving numerical software.

It has been divided into twenty-one different areas. Within each area the references are given in alphabetical order by the first author. Some references occur in two or at most three areas. This is especially true for the individual articles in the books of Section 2. For some entries a summary is included; either the original abstract, or a shortened form of the original, or a summary written by the present author.

The aim of the bibliography is to be useful in the production and evaluation of good software for numerical mathematics. However, it does not include references to algorithms in the numerical analysis literature, nor does it include references to individual software products (routines). Section 7 on bibliographies includes many entries not strictly within the scope of the present work. I have tried to get Sections 4 (Numerical Program Libraries), 11 (Transportability), and 16 (Evaluations) as complete as possible, but the other sections are not so well covered, especially as regards matters outside of numerical software.

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History of this Bibliography

A first version of this bibliography, with the title "An Annotated Bibliography on Mathematical Software and Related Topics," was written in 1974 by Eva Edberg and Jan Johansson and was later published in the SIGNUM Newsletter, Vol. 11, No. 2 (August 1976), pp. 9-16, and No. 3 (October 1976), p. 6. That version was produced at Uppsala University, with financial support from the Swedish Institute of Applied Mathematics and the Stockholm Data Center.

At the request of the IFIP Working Group on Numerical Software (IFIP WG 2.5) I started early in 1975 to collect additional material, and with the support of the Swedish National Defense Research Institute, a preliminary version was distributed in May 1976 and a slightly revised version in October 1976.

This version, which is the first version in the form of a formal report, was produced at the Computer Science Division and Electronics Research Laboratory, University of California, Berkeley, California.

It has been discussed by IFIP WG 2.5 to put the bibliography in machine readable form at a later time. Consequently I have chosen not to have the material retyped in a uniform manner and apologize to the reader for any resulting inconvenience.

Acknowledgements

I would like to thank Eva Edberg and Jan Johansson for their excellent original work. I also thank Ed L. Battiste, Fred N. Fritsch, Thos E. Hull, Tapio Niemelä, John R. Rice, and Larry F. Shampine for significant contributions.

My work on the present version has been supported by grants from the Sweden-America Foundation and the National Science Foundation, while the production of the present report has been financed by the Office of Naval Research Contract N00014-76-C-0013. I wish to express my sincere thanks to these three organizations for their support.

I am also very grateful to Professors Elwyn R. Berlekamp, William Kahan, and Beresford N. Parlett for their kind hospitality during my stay at the Computer Science Division of the University of California at Berkeley during the winter quarter of 1977.

Finally, I would like to thank Maj-Britt Kåhre, Agneta Österlund, and Suzanne Briggs for excellent typing of the many entries.

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RICE, John R.: SQARS - An Algorithm for Least - Squares Approximation, pp. 451 - 476.

FOX, P. A.: DESUB: Integration of a First-Order System of a Ordinary Differential Equations, pp. 477 - 507.

RICE, John R. (ed.): Mathematical Software - Madison, Proceedings of a conference, 28-30 March 1977. To be published by Academic Press.

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- G. H. Golub, "The block Lanczos method for computing Eigenvalues"
- G. W. Stewart, "Research, development, and LINPACK"
- M. J. D. Powell, "A technique that gains speed and accuracy in the minimax solution of over-determined linear equations"
- G. E. Collins, "Infallible calculation of polynomial zeros to specified precision"
- R. E. Barnhill, "Representation and approximation of surfaces"
- C. W. Gear, "Simulation: conflicts between real time and software"
- D. C. Hoaglin, "Mathematical software and exploratory data analysis"
- C. L. Lawson, "Software for C^1 surface interpolation"
- W. R. Cowell, L. D. Fosdick, "Mathematical software production"
- W. S. Brown, "Portability"
- I. Babuska, "Computational aspects of the finite element method"
- L. F. Shampine, "The art of writing a Runge-Kutta code"
- A. Brandt, "Multi-level adaptive techniques for partial differential equations: ideas and software"

SHAMPINE, L F and GORDON, M K: Computer Solution of Ordinary Differential Equations, The Initial Value Problem.
W H Freeman and Co, San Francisco 1975.

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3. STANDARDS

All the ANSI and ISO standards are available through your national standards organization.

American National Standard, Basic FORTRAN, ANSI X3.10-1966,
American National Standards Institute

American National Standard, FORTRAN, ANSI X3.9-1966, American National
Standards Institute

ANSI: American National Standard Cobol (ANS X3.23-1974). Also adopted
as ISO Recommendation R1989.

ANSI X3J3: Draft proposed revised Fortran standard. SIGPLAN Notices,
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Several revisions have been made since publication of the draft.

ANSI X3J3: Fortran 77 Full language, Working Document X3J3 76.5 of
1976-11-30. This document makes the draft proposed revised Fortran
Standard, published in the March 1976 special issue of SIGPLAN Notices,
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BSR X3.53 programming language PL/I (draft standard).

BSR X3.60, Programming Language Minimal Basic (draft standard).

BERKELEY, E. C. and BOBROW, D. G. (eds.): The programming language Lisp:
its operation and applications, M.I.T. Press, Cambridge, Mass., 1966.

CHAPIN, Ned: Flowcharting With the ANSI Standard: A Tutorial.
Computing Surveys, Vol 2, No. 2, June 1970, pp. 119-146.

CLARIFICATION of FORTRAN Standards - Initial Progress.
Comm. ACM 12 (1969), pp. 289-294.

CLARIFICATION of FORTRAN Standards - Second Report.
Comm ACM 14 (1971), pp. 628-642.

DAHL, O. J. et al.: Simula 67 common base language. Norwegian Computer Center publication S-22, 1971. Adr: Norsk Regnesentral, Forskningsveien 1b, Oslo, Norway.

DAY, A. C., CLARKE, P. A., HILL, D. and REID, J. K.: The proposed new standard for FORTRAN: a critical examination. The Computer Journal, Vol. 19 (1976), pp. 268-271.

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Geneva, April 1965.

FELDMAN, S. I.: A Fortraner's lament: comments on the draft proposed ANS Fortran standard. SIGPLAN Notices, Vol. 11, No. 12 (December 1976), pp. 25-34.

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FORD, Brian, REID, J. K. and SMITH, B. T.: Three proposed amendments to the draft proposed ANS Fortran standard. Submitted to SIGNUM Newsletter, September 1976. See also FORWARD, Fortran Development Newsletter, Vol. 2, No. 4 (October 1976), pp. 29-31.

P. A. Fox, A. D. Hall and N. L. Schryer,
"The PORT Mathematical Subroutine
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Report No. 47, Bell Laboratories, Murray
Hill, New Jersey, September 1976.

GRISWOLD, R. et al.: The Snobol 4 programming language, Second Ed., Prentice-Hall, Englewood Cliffs, 1971.

GROOMS, David W.: Computer software standards (a bibliography with abstracts). National Technical Information Service (June 1976), 92 pp. NTIS/PS-76/0411/9WC.

HANSON, R J; KROGH, F T and LAWSON, C L: A Proposal for Standard Linear Algebra Subprograms. JPL Tech. Mem. 33-660.

The purpose of this report is to propose a set of standard subprograms (modules) for performing many of the elementary operations of numerical linear algebra. The goal is to make it more feasible to produce efficient portable FORTRAN programs in the area of linear algebra.

HINDMARSH, A. C. and BYRNE, G. D.: A proposed ODEPACK calling sequence, UCID-30134, Lawrence Livermore Laboratory, May 1976, 13 pp.

The report contains a proposed list of calling sequence parameters for ordinary differential equation solvers.

IBM System 360 operating system, PL/I(F) language reference manual, IBM Order No. GC28-8201.

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Report on Subset ALGOL 60,
Comm. ACM Vol 7 No 10 pp 626-628 1964.

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Report on Input-Output procedures for ALGOL 60,
Comm. ACM Vol 7 No 10 pp 628-630 1964.

IFIP WG 2.1: Modified report on the algorithmic language ALGOL 60,
The Computer Journal, Vol. 19 (1976), pp. 364-379.

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IFIP WG 2.5: Amendments to Draft Proposed ANS FORTRAN, Specifying
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IFIP WG 2.5: Parameters for Transportable Numerical Software.
Manuscript July 1, 1976. Submitted to IFIP for publication.

IFIP WG 2.5: MAP Statement in Fortran to Assist in the Portability of
Numerical Software. Manuscript September 10, 1976 (16pp.)

ISO: ISO recommendation R1538, programming language Algol 60, International Organization for Standardization, 1972. (This standard is not recognized by IFIP, at least the first printing was erroneous.)

ISO Recommendation R1539, Programming Language FORTRAN, International Organization for Standardization, 1972

JENSEN, K and WIRTH, N: PASCAL, User Manual and Report.
Corrected reprint of the 2nd edition. 167 pp, US \$ 8.80.
Berlin-Heidelberg-New York: Springer Verlag, 1976.

KAIKOW, Howard: On FORTRAN Standards. SIGNUM Newsletter, Vol 9,
No. 3, July 1974, pp. 18-19.

KNUTH, D. E.: The remaining trouble spots in Algol 60, Communications
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LAMPSON, B. W. et al.: Report on the programming language Euclid, SIGPLAN
Notices, Vol. 12, No. 2, February 1977, Special issue, 3+79 pp.

This report describes the Euclid language, intended for the expression
of system programs which are to be verified. Euclid draws heavily
on Pascal.

LARMOUTH, J (1973): Serious FORTRAN, Software Vol 3, pp. 87-107.
Discusses writing of "serious" programs in a scientific environ-
ment. It is directed to those who intend to write FORTRAN
programs which have more than a transient life. This first part
deals with the implications of conforming to the ANSI standard
when writing FORTRAN.

LARMOUTH, J (1973): Serious FORTRAN - Part 2, Software Vol 3,
pp. 197-225.

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FORTRAN programs of more than transitory life deals with
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the design of user interfaces, debugging and program proving.

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Algebraic Operations. SIGNUM Newsletter, Vol 9, No. 2, April
1974, pp. 21-22.

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Linear Algebra Subprograms for Fortran Usage. Submitted.

LAWSON, C. and REID, J.: Two numerical analyst's views on the Draft Fortran. See COWELL, Wayne R. (ed.) in section 2, Books related to Numerical Software.

MATHEMATICAL CENTER: An extensive Test Set for ALGOL 68 Compilers has been assembled and comprises 160 programs covering the entire language. Please address requests to: Dick Grune, Mathematical Center, Tweede Boerhaavestraat 49, Amsterdam, The Netherlands.

McILROY, M D (1974): ANS Fortran Charts. Computing Science Technical Report No. 13, Bell Laboratories.

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NAG Reference Manual for Internal Project Use. NAG Central Office, Oxford University Computing Laboratory, 7 Banbury Road, Oxford OX2 6NN, England.

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NEEDHAM, Tom: Graphic extensions to the Basic language, Digest of Papers, Comp Con Spring 77, IEEE Catalog No. 77CH1165-0C, pp. 314-317.

PALME, Jacob: Experience from the Standardization of the SIMULA Programming Language. SOFTWARE - Practice & Experience, Vol 6, No. 3, July-September 1976, pp 405-409.

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STEEL, T. B.: Standards for computers and information processing. In "Advances in Computers," Vol. 8, F. L. Alt and M. Rubinoff (eds.), Academic Press, New York, 1967, pp. 103-152.

TRIANCE, J. M.: The significance of the 1974 COBOL standard, The Computer Journal, Vol. 19 (1976), pp. 295-300.

WAGENER, Jerrold L and RALSTON, Anthony: Critique of the Draft proposed Fortran Standard.

Summary in FOR-WORD, Fortran Development Newsletter, Vol 2, No. 3, July 1976, pp 24-26. Full text may be obtained from Wagener at the Computer Science Department, State University of New York, Brockport, New York 14420.

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4. NUMERICAL PROGRAM LIBRARIES

a) GENERAL ARTICLES

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BATTISTE, E. L.: The Production of Mathematical Software for a Mass Audience, pp. 121 - 130.

In RICE, John R (Ed): Mathematical Software, Based on the proceedings of the Mathematical Software Symposium held at Purdue University, Lafayette, Indiana, April 1970. Academic Press, New York 1971.

BATTISTE, E L: Mathematical Software Patterns. *SIGNUM Newsletter*, Vol 10, No. 1, January 1975, pp. 17-20.

BATTISTE, E. L., COWELL, W. R. and RICE, J. R.: Tutorial on organized activities and outlets for mathematical software. Audiocassette from ACM 76 National Conference in Houston, Texas. Available from Information Cassettes, 645 North Michigan Avenue, Chicago, Illinois 60611.

Contains information on various source types, technical, financial and organizational problems.

BATTISTE, Edward L.: Basic mathematical and statistical software problems, Proceedings of Computer Science and Statistics, 8th Annual Symposium on the Interface, University of California, Los Angeles (13-14 February 1975) p. 162.

BENSON, A. and EVANS, D. J.: Mathematical software. Software 71, D. J. Evans (ed.), Transcripta Books (1972), pp. 35-44.

BISH, D R B and COOPER, J R A: Guide to the NPL Algorithms Library. NPL Report NAC 64, February 1976. Division of Numerical Analysis and Computing, National Physical Laboratory, Teddington, England.

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CODY, W J (1974): The Construction of Numerical Subroutine-
Libraries, SIAM Review 16(1), pp. 36-46.

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University (1-2 April 1976), p. 76.

COWELL, Wayne R and FOSDICK, Lloyd D: A Program for
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Boulder, Colorado 80309. Report CU-CS-079-75, Sept. 1975.

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The Development and Maintenance of a Technical Subprogram
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Mathematical Software II, Informal Proceedings of a
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EINARSSON, Bo: Översikt av existerande programbibliotek (inom numerisk analys) (in Swedish). (A Review of Existing General Program Libraries (for Numerical Analysis)) ITM Working Paper No. 10 (1973).

Contains a description of the most usual program libraries with comments on availability, economical conditions and reliability. An addendum from March 1974 is also available from ITM.

EKBLOM, Håkan (1973): Matematisk programvara; problem och möjligheter (in Swedish) (Mathematical software; problems and possibilities), Ref: DATA No. 6

Concentrates on the role of the computer centre in distributing mathematical software. Contains a review of the Stanford study of FORTRAN programs by Knuth.

FADEN, Ben R (Ed) (1971): Computer programs directory. CCM Information Corp., New York, 399 pp.

This book is intended to serve as a unified program library catalog for the unit members within the Joint User Group of the ACM. The book can be important in efforts to develop industry-wide standards for program documentation, because there are already standards in force within the individual units.

The directory contains two main sections: a program description section and a subject index. About 1000 programs from 11 units are listed, the most recent additions having been made in late 1970.

The 1974 edition is available from Macmillan Information, 866 Third Avenue, New York.

FORD, Brian: The Nottingham Algorithms Group (NAG) Project. SIGNUM Newsletter, Vol 8, No. 2, April 1973, pp. 16-21.

FORD, B and HAGUE, S J: The organisation of numerical algorithms libraries, pp. 357-372.

In EVANS, D J (Ed): Software for Numerical Mathematics. Proceedings of the Loughborough University Conference of the Institute of Mathematics and Its Applications held in April 1973, Academic Press, London 1974.

FORD, B and SAYERS, D K: Developing a Single Numerical Algorithms Library for Different Machine Ranges. ACM Transactions on Mathematical Software, Vol 2, No. 2, June 1976, pp 115-131.

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FRANCE, James W.: The BMD and BMDP series of statistical computer programs. Communications of the ACM, Vol. 19, (October 1976), pp. 570-576.

FRITSCH, F. N.: Construction of mathematical software, part 1: general design. UCID-30050, part 1. Lawrence Livermore Laboratory, August 1972, 34 pp.

GEPNER, Herbert L.: User ratings of software packages, Datamation (December 1976), pp. 108-133.

More detailed results are available as "User Ratings of Proprietary Software" for \$12 from Datapro Research Corporation, 1805 Underwood Boulevard, Delran, New Jersey 08075.

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The Design and Implementation of an Algol 68
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In: Rice, John R.
Mathematical Software II, Informal Proceedings of a
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Purdue University, May 29-31, 1974.

INTERNATIONAL COMPUTER PROGRAMS Inc: Software Directory.
1119 Keystone Way, Carmel, Indiana 46032.

More than 3,000 proprietary software products produced by more than 800 vendors are described in the latest semiannual, two-volume ICP Software Directory. The first volume (338 pp.) is on systems software, and the second (614 pp.) covers applications software. There are over 2,000 product updates in this version, plus 600 new product listings. Price: \$100/yr. by subscription, or \$60 for two volumes on a one-time basis.

JOHNSON, O G: IMSL's Ideas on Subroutine Library Problems.
SIGNUM Newsletter, Vol 6, No. 3, November 1971, pp. 10-12.

NEWBERY, A. C. R.: The Boeing Library and Handbook of Mathematical Routines, pp. 153 - 169.

In RICE, John R (Ed): Mathematical Software. Based on the proceedings of the Mathematical Software Symposium held at Purdue University, Lafayette, Indiana, April 1970. Academic Press, New York 1971.

PILKLY, W; SACZALSKI, K and SCHAEFFER, H: Structural Mechanics Computer Programs, Surveys, Assessments, and Availability. University Press of Virginia, Charlottesville, 1975, 1100 pp., Price: \$20.

POOL, J. C. T.: Mathematical software in the network environment. Argonne National Laboratory (1976), 22 pp. CONF-760550-2 (available from NTIS).

PRENTICE, J. A.: The development and maintenance of multi-machine software in the NAG project, pp. 383 - 391.

In EVANS, D J (Ed): Software for Numerical Mathematics. Proceedings of the Loughborough University Conference of the Institute of Mathematics and Its Applications held in April 1973, Academic Press, London 1974.

RICE, John R.: The Distribution and Sources of Mathematical Software, pp. 13 - 25.

RICE, John R.: The Challenge for Mathematical Software, pp. 27 - 41.

In RICE, John R (Ed): Mathematical Software. Based on the proceedings of the Mathematical Software Symposium held at Purdue University, Lafayette, Indiana, April 1970. Academic Press, New York 1971.

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RICE, John R.: Software for numerical computation. Report CSD-TR214, January 1977, Mathematical Sciences, Purdue University. Article to appear in the book: Research Directions in Software Technology.

RICHARDSON, M G and HAYES, S J: The Design and Implementation of the NAG Master Library File System. SOFTWARE - Practice & Experience (1976). In Press.

SCHLECHTNER, O; SCHMID, F and ZELLE, K: Algorithmen Programme
Programmpakete, Institut für Stadtforschung, Währinger-
strasse 6-8, A-1090 Wien. Verlag Jugend & Volk, Wien (Schilling 300)
A Catalog of more than 3000 subroutines from journals, research
centers, and computer manufacturers.

SMITH, B. T., BOYLE, J. M. and CODY, W. J.: The NATS approach
of quality software, pp. 393 - 405.

In EVANS, D J (Ed): Software for Numerical Mathematics.
Proceedings of the Loughborough University Conference of
the Institute of Mathematics and Its Applications held
in April 1973, Academic Press, London 1974.

SMITH, B.T. et al: Matrix Eigensystem Routines, EISPACK
Guide, Second Edition , Lecture Notes in Computer Science,
Vol. 6, Springer-Verlag, Berlin-Heidelberg-New York 1976.

STETTER, Hans J: Some Aspects of Numerical Software.
IFIP WG 2.5 Position Paper, January 13-16, 1975, Oxford
University, 5 pp.

TAYLOR, D. B., FORD, B. and HAGUE, S. J.: Management practices
in the development and distribution of mathematical software
with emphasis on computational aids in multi-machine environment,
pp. 373 - 382.

In EVANS, D J (Ed): Software for Numerical Mathematics.
Proceedings of the Loughborough University Conference of
the Institute of Mathematics and Its Applications held
in April 1973, Academic Press, London 1974.

TRAUB, J. F.: High Quality Portable Numerical Mathematics
Software, pp. 131 - 139.

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proceedings of the Mathematical Software Symposium held
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WAITE, W M: Hints on Distributing Portable Software. Software Practice and Experience, Vol 5, pp. 295-308 (1975).

WITTMAN, J R (1975): A Bibliography for Finite Elements. 202 pp. Academic Press, London.

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Ref: Inst. Maths. Applics, Vol 16(1), 1975.

ZIELKE, G: ALGOL-Katalog Matrizenrechnung. München-Wien: R. Oldenbourg Verlag. 1972. DM 32.-, 148 pp.

A catalog of more than 400 published Algol procedures for matrix problems, with comments on accuracy and usefulness.

4. NUMERICAL PROGRAM LIBRARIES

b) SOME COMMERCIAL NUMERICAL LIBRARIES (available at cost)

1. IMSL is a mathematical and statistical subroutine library in Fortran, available for IBM 360/370, Xerox, UNIVAC 1100, Honeywell-Bull 600/6000, DEC System-10, CDC 6600/7600/ CYBER 70/170, Burroughs 6700/7700

It is used at five hundred computer centers. New release each year as announced. Further information from International Mathematical & Statistical Libraries, Inc., 7500 Bellaire Boulevard, Sixth Floor, GNB Building, Houston, Texas 77036. Tel. (713) 772-1927.

2. NAG is a British subroutine library, available in both Fortran and Algol 60. An Algol 68 version is being developed. Versions exist for IBM 360/370, CDC 6600/7600, CYBER 70/170, Burroughs 5700/6700/7700, UNIVAC 1100, PRIME, DEC System 10 and various ICL computers. It is used extensively in British Universities and is now being made available internationally. Further information from the NAG Central Office. 7 Banbury Road, Oxford OX2 6NN, England. Tel (0865) 511245. New release each year as announced. Work is in progress on a version for GEC computers.

Ref. Bulletin of the Institute of Mathematics and its Applications, Nov 1972, SIGNUM Newsletter, Vol. 8, No. 2 (April 1973), pp. 16-21, and in "Software for Numerical Mathematics", Ed. by D.J. Evans, Academic Press, London 1974.

3. The PORT Mathematical Subroutine Library is a rather recent software product from Bell Laboratories, Murray Hill, New Jersey 07974. It has been written with particular emphasis on portability, which is achieved by careful language specification and specifying computer classes by means of predefined machine constants. The library has been described by Phyllis Fox, see references in section 2, COWELL, Wayne R (Editor) with entry FOX and section 4a. The library has been tested extensively on IBM and Honeywell.

Information on availability is given in the SIGNUM Newsletter, Vol. 11, No. 2 (August 1976), p. 8.

P. A. Fox, A. D. Hall and N. L. Schryer,
"The PORT Mathematical Subroutine
Library", Computing Science Technical
Report No. 47, Bell Laboratories, Murray
Hill, New Jersey, September 1976.

4. SL-Math is a numerical program library available as a Program Product from IBM. The source code, written in Fortran, contains routines for sparse matrices. Ref. IBM System/360 and System/370, IBM 1130 and IBM 1800, Subroutine Library-Mathematics, User's Guide SH 12-5300-0, and Subroutine Library Mathematics, General Information GH 12-5103-0, (1971).

A version in PL/1 is called PL-Math, but does not contain the sparse routines.

5. BOEING has developed a large numerical program library for use on CDC computers. A description is in A.C.R. Newbery, "The Boeing Library and Handbook of Mathematical Routines", in "Mathematical Software", Ed. by John R. Rice, Academic Press, New York 1971, pp. 153-169.

Further information from Control Data. This library is now considered almost obsolete.

4. NUMERICAL PROGRAM LIBRARIES

c) SOME NON-COMMERCIAL NUMERICAL LIBRARIES

1. SSP. This old and well-known Fortran library from IBM is available on most computers. It is considered to be out-of-date but still used. There also exists a PL/1 version (The only known non-commercial PL/1 library?) Ref. System/360 Scientific Subroutine Package, Version III, Programmer's Manual GH 20-0205-3 with Technical Newsletter N 20-1944.
2. MATH-PACK. Univac has a Fortran library similar to SSP. Most other computer manufacturers also have similar libraries.
3. CNRS. A collection "Procedures Algol en Analyse Numérique" has been issued by Centre National de la Recherche Scientifique, Service des Publications, Ventes 15, Quai Anatole-France, Paris 7.
4. HARWELL. The United Kingdom Atomic Energy Authority Research Group at Harwell has a large Fortran library, that is being used also at many other centers. Further information is available from Mr S. Marlow, Building 8.9, AERE, Harwell, Oxfordshire OX11 0RA. See also the report AERE-R 7477, A catalogue of Subroutines.

The original version is for IBM 360/370. The library is specially strong in optimization and sparse matrices.

5. NPL. The National Physical Laboratory has a large library of routines which aims to cover most numerical processes widely required in the scientific disciplines. The Algorithms are coded in Algol 60 and Standard Fortran although some may be available in one language only. The highest degree of machine and compiler independence has been aimed at. There is one document for each algorithm for each available language. Routines may be supplied individually.

The library is based upon expertise accumulated by numerical analysts at NPL through years of research and problem solving. These analysts may be consulted upon most numerical problems and usually provide advice and assistance in the early stages of use of an algorithm. Material is continually added to the library as a result of research effort at NPL.

A guide to the library will be supplied free of charge upon application to: Dr. J.R.A. Cooper, Division of Numerical Analysis and Computing, National Physical Laboratory, Teddington, Middlesex TW11 0LW.

6. NATS. National Activity to Test Software is a United States project managed by the Applied Mathematics Division of the Argonne National Laboratory in cooperation with universities in North America and Europe. So far the eigensystem package EISPACK and the special functions package FUNPACK are available for all main U.S. computers.

Further information from Burton S. Garbow, Applied Mathematics Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439.

EISPACK is available for IBM 360/370, CDC 6600/7600, UNIVAC 1100, DEC System-10, Honeywell 600/6000 and Burroughs 6700.

FUNPACK is available for IBM 360/370, CDC 6600/7600 and UNIVAC 1100.

Ref. Garbow, B.S.: EISPACK - A Package of Matrix Eigensystem Routines, Computer Physics Communications, Vol. 7, No. 4, (April 1974), pp.179-184.

Smith, B.T., et al: Matrix Eigensystem Routines-EISPACK Guide, Lecture Notes in Computer Science, Volume 6, Second Edition, Springer-Verlag, Berlin-Heidelberg - New York, 1976.

7. JPL. The Jet Propulsion Laboratory in Pasadena, California has a private library, described in Report 1846-23; Rev. A, February 1, 1975. This report is an excellent example of how a private library ought to be documented and presented to its local users.

8. NUMAL.

On request of the Academic Computing Centre of Amsterdam (SARA) the Mathematical Centre adapted and extended its library of numerical procedures for use with the CD CYBER 70 System, the resulting library called "NUMAL" ("NUM" ERICAL PROCEDURES IN "AL"GOL 60).

The aim of NUMAL is to provide a high level numerical library for Algol 60 Programmers. The library contains a set of validated numerical procedures together with supporting documentation. Except for a small number of double precision arithmetic routines all the source texts are written in Algol 60 and they are to a high degree independent of the computer/compiler used.

The library is now in use by several scientific computer centers in the Netherlands. Full reference documentation (ca. 800 pages) is distributed to subscribers. Once a year additions and improvements are released.

Ref. Mathematical Centre report NW8/76: NUMAL, a library of numerical procedures in ALGOL 60. Index and KWIC-index (3rd edition).

Further information from Stichting Mathematisch Centrum, 2e Boerhaavestraat 49, Amsterdam-1005, The Netherlands.

9. CERN. The "Centre Européenne pour la Recherche Nucléaire" in Geneva has one of the largest subroutine libraries in Europe. It is intended for the CDC 6600/7600 series, but mappings exist to other systems, including UNIVAC 1100. Some routines are very machine dependent. The library is classified according to SHARE and contains three categories
- a) numerical routines
 - b) data manipulation routines
 - c) nuclear physics applications

Further information from Program Librarian, CERN, Div. 23, CH-1211 Geneva 23, Switzerland.

10. CPC (Computer Physics Communications Program Library).
Computer programs in Physics are being collected at the Queen's University of Belfast and are announced in the Computer Physics Communications, see Volume 1 (1970), pp. 473-476 and Volume 10 (1975), p. 203. The current indexes of the contents of the program library as well as the programs are available from the C.P.C. Program Library, School of Physics and Applied Mathematics, Queen's University, Belfast BT7 1NN, Northern Ireland.
11. ANL. The Argonne Code Center is responsible for operating a computer software and data exchange and information center under U.S. Energy Research and Development Administration. Registered Installations receive a copy of the Program Abstracts, ANL 7411. A nominal fee is required for non-ERDA installations. Information is available from:
Argonne Code Center
Argonne National Laboratory
9700 South Cass Avenue
ARGONNE, Illinois 60439.
12. CACM. Collected algorithms from ACM is a collection of the algorithms published in the Communications of the ACM and ACM Transactions on Mathematical Software. The 1976 Index is published in Communications of the ACM, Vol. 19 (1976), p. 696. Further information from ACM.

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K. A. REDISH - McMaster University
Tree Structures for a Program Library Index

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West Lafayette
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Summary

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b) GUIDELINES FOR TRANSPORTABLE EVALUATION TOOLS

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15. CRITERIA FOR EVALUATING NUMERICAL SOFTWARE

c) CRITERIA FOR EVALUATING QUADRATURE, ORDINARY DIFFERENTIAL EQUATION AND INTEGRAL EQUATION SOFTWARE

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Factors involved in the development of good software are discussed, with practical reference to programs for solving ODE's. These factors include the basic structuring of the programs themselves, along with the appropriateness of various language facilities, comparisons of efficiency, proofs of correctness, certification and distribution e t c.

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An algorithm is presented for computing exactly general solutions for systems of linear equations with integer or polynomial coefficients.

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A computing time study of several algorithms for the exact solution of systems of linear equations with integer or polynomial coefficients is presented. The analytical computing times for rational Gauss elimination, exact division elimination (one-step and two-step), and the modular algorithm are summarized and supplemented. Extensive empirical studies illustrate the superiority of the modular algorithm in agreement with the analytical results. All algorithms were programmed in FORTRAN IV for the SAC-1 System and all cases were run on a UNIVAC 1108.

CLEVE B. MOLER - University of New Mexico
Software for Matrix Computations

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A Comparison of the PLU and QR Methods for Determining Eigenvalues of Real Hessenberg Matrices

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An algorithm is developed for obtaining eigenvalues of real, symmetric, tridiagonal matrices. It combines dynamically Given's method of bisection and the use of Sturm sequences with various acceleration devices. A FORTRAN IV computer implementation of the algorithm was used on ten test matrices found in the literature. The new method is as precise and reliable as the best published program (Kahan and Varah, 1966), it is never slower, and in at least one case is two and a half times faster than the Kahan and Varah program.

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In RICE, John R (Ed): Mathematical Software. Based on the proceedings of the Mathematical Software Symposium held at Purdue University, Lafayette, Indiana, April 1970. Academic Press, New York 1971.

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W. ENRIGHT, R. BEDET, G. HALL, T. HULL and B. LINDBERG -
University of Toronto

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On the Evaluation of Numerical Methods for Initial
Value Problems in Ordinary Differential Equations

In: Rice, John R.
Mathematical Software II, Informal Proceedings of a
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FOX, P. A.: DESUB: Integration of a First-Order System of a Ordinary Differential Equations, pp. 477 - 507.

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A study comparing the performance of several computer programs for integrating systems of ordinary differential equations (initial value problems) is reported. The integration methods represented include multistep methods (predictor-correctors), single-step methods (Runge-Kutta) and extrapolation methods (both polynomial and rational). The testing procedure is described together with the evaluation criteria applied. A set of 7 test problems on which the programs were tested is included in an appendix. For the particular problems and criteria used in the investigation it was found that a program based on rational extrapolation showed best performance. 25 references are given.

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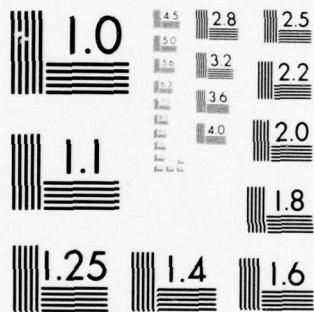
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The following journals publish algorithms and/or computer codes within the numerical software area:

ACM Transactions on Mathematical Software (Association for Computing Machinery, 1133 Avenue of the Americas, New York, New York 10036)

Angewandte Informatik (Friedr. Vieweg + Sohn GmbH, Burgplatz 1, D-3300 Braunschweig, German Federal Republic)

BIT (DATA A/S, Kronprinsensgade 14, DK-1114 Copenhagen K, Denmark)

Communications of the ACM (Association for Computing Machinery, 1133 Avenue of the Americas, New York, New York 10036)

Computer Journal (British Computer Society, 29 Portland Place, London W1N 4AP, England)

Computer Physics Communications (North-Holland Publishing Company, P.O.Box 103, Amsterdam W, The Netherlands)

Computing (Springer-Verlag, P.O.Box 367, A-1011 Vienna, Austria)

Journal of Computational and Applied Mathematics (Koninklijke Vlaamse Ingenieursvereniging, Jan van Rijswicijcklaan 58, B-2000 Antwerp, Belgium)

Numerische Mathematik (Springer-Verlag, Heidelberger Platz 3, D-1 Berlin 33, German Federal Republic)

The following are important review journals:

Computing Reviews (Association for Computing Machinery,
1133 Avenue of the Americas, New York, New York 10036)

This journal also has the annual "Bibliography
and Subject Index of Current Computing Literature".

CPST, Computer programs in science and technology. Science Associates/
International, Inc., 23 East 26th Street, New York, NY 10010 (Annual
subscription \$95.00).

Computer and Information Systems, Cambridge Scientific Abstracts, Inc.,
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This bibliography has been written at the request of the IFIP Working Group on Numerical Software (IFIP WG 2.5), and is intended to serve both members of the working group and others intent on improving numerical software. It has been divided into twenty-one different areas. Within each area the references are given in alphabetical order by the first author. Some references occur in two or at most three areas. This is especially true for the individual articles in books. For some entries a summary is included; either the original abstract, or a shortened form of the original, or a summary written by the present author.		

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The aim of the bibliography is to be useful in the production and evaluation of good software for numerical mathematics. However, it does not include references to algorithms in the numerical analysis literature, nor does it include references to individual software products (routines). The section on bibliographies includes many entries not strictly within the scope of the present work. I have tried to get the sections on Numerical program libraries, Transportability, and Evaluations, as complete as possible, but the other sections are not so well covered, especially as regards matters outside of numerical software.